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मापन और नियंत्रण के लिए टाइम-स्विच

(दूसरा पुनरीक्षण)

Indian Standard

TIME SWITCHES FOR METERING AND LOAD CONTROL

(Second Revision)

ICS 29.120.60

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 7

Equipment for Electric Energy Measurement and Load Control Sectional Committee, ETD 13

FOREWORD

This standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Equipment for Electric Energy Measurement and Load Control Sectional Committee had been approved by the Electrotechnical Division Council.

The time switches are being extensively used for regulating the switching operation of Electrical Circuits such as multirate tariff meters. The object of this standard is to lay down the uniformity for the design, construction and testing of time switches with a view to provide guidance to the indigenous industry.

This standard was originally published in 1961 and was revised in 1973 to update the requirement of the latest manufacturing practices as well as the experience gained through the implementation of the standard. In the first revision the current ratings were aligned with the internationally expected ratings keeping only three ratings as against earlier six ratings. General conditions of tests were added and classification of tests was revised in addition to incorporating acceptance test and sampling plan.

The second revision has been undertaken to bring in line with the international recommendations. It includes requirements of only newly manufactured self contained time switches with operation reserve as against all type of time switches in the previous standard. Other salient features of the revisions are as follows:

a) Special requirements of tests for crystal control time switches have been included.

b) Tests on mechanical, electrical environmental requirements are added.

For the preparation of this standard, assistance has been derived from IEC publication IEC 1038 : 1990 'Time switches for tariff and load control' issued by the International Electrotechnical Commission.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

TIME SWITCHES FOR METERING AND LOAD CONTROL

(Second Revision)

1 SCOPE

This standard specifies the requirements for the type test of newly manufactured self-contained time switches with operation reserve that are used to control electrical loads, multi-tariff registers and maximum demand devices at certain days and hours throughout the year. These time switches may employ various types of operation including the use of static circuits.

This standard includes the time switches with analogue dials on digital display that are:

- Synchronous, and
- Crystal controlled.

Standard does not apply to time switches operated by remote control or synchronized by radio-frequency.

2 REFERENCES

The Indian Standards given in Annex A are necessary adjuncts to this standard.

3 DEFINITIONS

3.1 General Definitions

3.1.1 *Time Switch*

A device which may be set to make or break or change over circuits at pre-determined times.

3.1.2 *Synchronous Time Switch*

A time switch having, as its main time base, the network frequency.

3.1.3 *Crystal Controlled Time Switch*

A time switch having, as main time base, a crystal controlled oscillator.

3.1.4 *Rated Supply Voltage* (U_n)

Value of the supply voltage for which the time switch is designed.

3.1.5 *Rated Supply Frequency* (f_n)

Value of the supply frequency for which the time switch is designed.

3.1.6 *Rate of Supply Current* (I_n)

Under consideration.

3.2 Definitions Related to the Functional Elements

3.2.1 *Time Based Element*

The part of the time switch produces an output proportional to the time.

3.2.1.1 *Time indication discrepancy*

The difference between the time displayed by the time switch and the actual time, or in the case of synchronous time, the difference between the time displayed by the time switch and the time, determined by the network frequency.

3.2.1.2 *Time-keeping accuracy*

The increase or decrease in the time indication discrepancy wishing a specified time interval.

3.2.1.3 *Operation reserve*

The maximum period of time for which the supply voltage may be interrupted without affecting the correct time keeping off the time switch.

3.2.1.4 *Reserve restoration time*

The period of time required for the full operation reserve from the point where the operation reserve has been completely exhausted.

3.2.2 *Setting and Display Element*

3.2.2.1 *Dial*

An analogue device for facilitating the setting and observation of the settings of the time switch and for the display of indicated time. The dials are designated according to their period of rotation (for example, the day dial has a period of rotation of 1 day).

3.2.2.2 *Display*

A digital device for facilitating the setting and observation of the setting and observation of the settings of the time switch and for the display of indicated time and switch status.

3.2.3 *Output Element*

Element comprising one or more switches controlled according to the information provided by the based element.

3.2.3.1 *Load switch*

That part of the time switch comprising the contacts, or their static equivalent, for switching loads, together with the parts directly operating the contacts.

3.2.3.2 *Tariff register switch*

The part of the time switch comprising the contacts, or their static equivalent, for switching tariff registers, together with the parts directly operating the contacts.

3.2.3.3 *Maximum demand indicator switch*

That part of the time switch comprising the contacts, or their static equivalent, for switching maximum demand indicators, together with the parts directly operating the contacts.

3.2.3.4 *Rated breaking voltage* (U_c)

The value of the voltage for which a switch or switches are designed.

3.2.3.5 *Rated breaking current* (I_c)

The value of current for which a switch is designed and which it may close, carry continuously and break under specified conditions.

3.2.3.6 *Operation*

A pair of changes of state of an output element, closure followed by opening or *vice-versa.*

3.3 Definition of Mechanical Elements

3.3.1 *Time Switch Base*

The back of the time switch by which it is generally fixed, and to which are attached the frame or the electronic board(s) the output element(s), the terminals, or the terminal block and the cover.

3.3.2 *Time Switch Cover*

The enclosure in the front of the time switch made either wholly of transparent material or of opaque material provided with a window(s) through which the dial and/or display may be read.

3.3.3 *Time Switch Case*

The case comprised the base and the cover.

3.3.4 *Accessible Conducting Part*

A conducting part which may be touched by the standard test finger, when the time switch is installed ready for use.

3.3.5 *Protective Earth Terminal*

The terminal connected to accessible conducting parts of a time switch, for safety purposes.

3.3.6 *Terminal Block*

A support made of insulating material on which all or some of the terminals of the time switch are grouped together.

3.3.7 *Terminal Cover*

A cover which covers the time switch terminals, and generally the ends of the external wires or cables connected to the terminals.

3.3.8 *Clearance*

The shortest distance measured in air between conductive parts.

3.3.9 *Creepage Distance*

The shortest distance measured over the surface of insulation between conductive parts.

3.4 Definition of Insulation

3.4.1 *Basic Insulation*

The insulation applied to live parts to provide basic protection against electric shock.

NOTE — Basic insulation does not necessarily include insulation used exclusively for functional purpose.

3.4.2 *Supplementary Insulation*

The independent insulation applied in addition to the basic insulation, in order to provide protection against electric shock in the event of a failure of the basic insulation.

3.4.3 *Double Insulation*

The insulation comprising both, basic insulation and supplementary insulation.

3.4.4 *Reinforced Insulation*

A single insulation system applied to live parts, which provides degree of protection against electric shock equivalent to double insulation.

NOTE — The term 'insulation system' does not imply that the insulation should be one homogeneous piece. It may comprise several layers which should not be tested singly as supplementary or basic insulation.

3.4.5 *Insulation Encased Time Switch of Protective Class II*

A time switch with a case of insulation material in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation of reinforced insulation, are provided, there being no provision for protective earthing or reliance upon installation conditions.

3.5 Definition of Influence Quantities

3.5.1 *Influence Quantity or Influence Factor*

Any quantity or any factor, generally external to the time switch, which may affect its working performance.

3.5.2 *Reference Conditions*

The appropriate set of influence quantities and performance characteristic with reference value with their tolerances and reference ranges, with respect to which the working performances are specified.

3.5.3 *Variation of Time Indication Due to an Influence Quantity*

The difference in time keeping accuracy of a time switch when only one influence quantity assumes successively two specified values, one of them being the reference value.

3.5.4 *Electromagnetic Disturbances*

Electromagnetic disturbances are those conducted radiated effects which may affect functionally or metrologically, the operation of the time switch.

3.5.5 *Reference Temperature*

The ambient temperature specified for reference conditions.

3.5.6 *Operating Temperature*

A set of specific ranges for performance characteristics and specified operating ranges for influence quantities, within which the variations or working performance of a time switch are specified and determined.

3.5.7 *Specified Operating Range*

A range of values of a single influence quantity which forms a part of the operating conditions.

3.5.8 *Limit Range of Operation*

The extreme conditions which an operating switch may withstand without damage and without degradation of its characteristics when it is subsequently operated under its operating conditions.

3.5.9 *Storage and Transport Conditions*

The extreme conditions which a non-operating switch may withstand without damage and without degradation of its characteristic when it is subsequently operated under its operating conditions.

3.5.10 *Normal Working Position*

The position of time switch defined by the manufacturer normal service.

3.6 Definition of Tests

3.6.1 *Type Test*

All the individual tests and examinations intended to establish the characteristics of a type of time switch and to prove its conformity to the requirements with which it must comply.

3.6.2 *Routine Test*

Tests carried out on each time switch suitable to check the conformity with the requirements of this standard in aspects which are likely to vary during production.

3.6.3 *Acceptance Tests*

Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

4 REQUIREMENTS

4.1 Standard Electrical Values

4.1.1 *Standard Rated Supply Voltage*

Standards values for rated supply voltage are 110V to 240 V ac or 415 V ac.

4.1.2 *Standard Rated Supply Frequency*

Standard value for rated supply frequencies is 50 Hz.

4.1.3 *Standard Rated Supply Current*

Under consideration.

4.2 Mechanical Requirements

4.2.1 *General Mechanical Requirements*

Time switches shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially:

a) Personal safety against electric shock;
b) Personal safety against effects of excessive temperature;
c) Safety against spread of fire; and
d) Protection against solid objects, dust and water.

All parts which are subject to corrosion under normal working conditions shall be effectively protected. Any protective coating shall not be liable to damage by ordinary handling nor injuriously by exposure to air, under normal working conditions.

The time switch shall have adequate mechanical strength and shall withstand the elevated temperature which is likely to occur in normal working conditions.

The components shall be reliably fastened and secured against loosening. The switch sensing systems (tappets and lever) should preferably be of metal for better accuracy repeatability.

The construction of the time switch shall be such as to minimize the risk or short-circuiting of the insulation between live parts and accessible conducting parts due to accidental, loosening or unscrewing of the wiring, screws, etc.

4.2.2 *Time Switch Case*

Time switches shall have a resonably dust proof, non-ignitable, non-hygroscopic and mechanically strong case (preferably of steel) which may be sealed in such a way that the internal parts of the time switch are accessible only after breaking the seals.

The case shall be designed according to Protective Class I or Protective Class II

The cover shall not be removable without the use of a tool, coin or any similar device.

The case shall be so constructed and arrange that any non-permanent deformation may not prevent the statisfactory operation of the time switch.

Unless otherwise specified, time switches intended to be connected to a main supply where the voltage under reference conditions exceeds 250 V to earth, and whose case is wholly or partially made of metal shall be provided with a protective earth terminal.

4.2.3 *Window(s)*

If the cover is not transparent, one or more windows shall be provided for reading the display and observation of the operation indicators if fitted. Those window shall be of transparent material which may not be removed without breaking the seals.

4.2.4 *Terminals, Terminal Block, Protective Earth Terminal*

Terminals may be grouped in a terminal block(s) having adequate insulating properties and mechanical strength. In order to satisfy such requirements, when choosing insulating materials for the terminal block(s), adequate testing of materials should be taken into account.

The holes in the insulating materials which form an extension of the terminal holes shall be of sufficient size to accommodate also the insulation of the conductors.

The manner of fixing the conductors to the terminals shall ensure adequate and durable contact such that there is no risk of loosening or undue heating, screw connections transmitting contact force and screw fixing which may be loosened and tightened several times during the life of time switch shall screw into a metal nut.

For time switches with rated breaking currents up to 25A, when screw type terminals are used, it shall be possible to connect either one conductor of at least 1.5 mm^2 in each terminal or 2 conductors of 1.5 mm^2 in each terminals.

If a system other than screw type terminals is used for connection of the conductors, this system shall retain its full efficiency after 50 connections and disconnections.

All parts of every terminals shall be such that the risk of corrosion resulting from contact with any other metal part is minimized.

Electrical connections shall be so designed that contact pressure is not transmitted through the insulating material.

Terminals with different potentials which are grouped close together shall be protected against accidental short-circuting. Protection may be obtained by insulating barrier. Terminals of one output circuit are considered to be at the same potential.

The terminals, the conductor fixing screws, or the external or internal conductors shall not be liable to come into contact with metal terminal covers.

The protective earth terminals, if any.

a) shall be electrically bonded to the accessible metal parts;
b) should, if possible form part of the time switch base;
c) should preferably be located adjacent to its terminal block;
d) shall accommodate a conductor having a cross-section at least equivalent to one of the output circuits, of the highest rating; and
e) shall be clearly indentified by the earthing symbol.

After installation, it shall not be possible to loosen the protective earth terminal without the use of a tool.

4.2.5 *Terminal Cover(s)*

The terminals of a time switch, if grouped in a terminal block and if not protected by any other means, shall have a separate cover which may be sealed independently of the time switch cover. The terminal cover shall enclose the actual terminals, the conductor fixing screws and, unless otherwise specified, as suitable length of the external conductors and their insulation.

When the time switch is panel-mounted, no access to the terminals shall be possible without breaking the seal(s) of the terminal cover(s).

4.2.6 *Clearance and Creepage Distances*

The clearance and creepage distances of the terminal block and those between the terminals and the surrounding parts of the metal enclosure shall be not less than the values specified in Table 1.

The clearance between the terminal cover, if made of metal, and the upper surface of the screws when screwed down to the maximum applicable conductor fitted shall be not less than the relevant values indicated in Table 1.

Table 1 Clearances and Creepage Distances for the Terminal Block

(*Clause* 4.2.6)

Voltage Phase to Earth (V)	Minimum Clearances (mm)	Minimum Creepage Distance (mm)
(1)	(2)	(3)
Not exceeding 50	0.8	1.2
Not exceeding 100	0.8	1.4
Not exceeding 150	1.5	1.6
Not exceeding 300	3.0	3.2
Not exceeding 600	5.5	6.3

The requirement of the impulse voltage test shall also be met.

4.2.7 *Marking of Dials*

For time switches with analogue dials:

a) The direction of rotation of the dials shall be marked by an arrow;

b) The hour dial (if any) shall be capable of being read to the nearest minute;

c) When required, the hours on the day dial and the days on the week dial shall be marked in a different colour; and

d) All markings shall be indelible and easily readable.

4.2.8 *Display*

For time switches with digital display:

a) The display shall be easily readable. If the same digital display is used for displaying different quantities, then a code or other indication shall be displayed to enable each quantity to be identified; and

b) The display time of each quantity shall be at least 6 seconds.

4.2.9 *Setting*

On a day dial or display the settings shall be adjustable in such a way that the actual switching times do not differ from the set times by more than ±5 minutes. It shall be possible to arrange two successive switching operations within a period of 30 minutes.

On a week dial or display the settings shall be adjustable in such a way that the actual switching times do not differ from the set times by more than ±60 minutes.

On a year dial or display the setting shall be adjustable in such a way that the actual switching times do not differ from the set time by more than ±2 days.

The initial point of operation of a maximum demand indicator switch shall be manually adjustable, unless it is set automatically by the day dial. In the case of crystal controlled time-switches with a digital display, this initial point of operation shall be adjustable to an integer number of hours clock time.

4.2.10 *Marking of Time Switches*

The marking shall be easily readable without removing the cover.

Every time switch shall bear the following information, if applicable.

a) The designation 'Time switch';

b) Manufacturer's name or trade-mark, and, if required, the place of manufacture;

c) The type designation;

d) The serial number and year of manufacture;

e) The rated supply voltage (U_n);

f) The rated supply frequency (F_n);

g) The rated breaking voltage (U_c);

h) The rated breaking current (I_c);

j) The integration time of the maximum demand indicator switch t_m and the detent time (t_o) or, if adjustable, the adjustment range;

k) The operating reserve;

m) The total current carrying capacity of all the output elements; I_{tol} (this value is lower than the sum of the rated breaking current of all the output switches of the time switch);

n) A space for battery change date; and

p) The sign of double square for insulating encased time switches of protective class II.

The time switch shall be identifiable without its cover at least by its serial number.

4.2.11 *Connection Diagrams and Terminal Marking*

Every time switch shall be indelibly marked with a diagram of connections. It is permissible to indicate the connection diagram by an identification figure in accordance with national standards.

If the time switch terminals are marked, this marking shall appear on the diagram.

4.2.12 *Special Requirement for Crystal-Controlled Time Switches*

Access points shall be provided to test the frequency of the time base of a crystal contolled time switch.

4.3 Climatic Conditions

4.3.1 *Temperature Range*

The temperature range of the time switch shall be as shown in Table 2.

Table 2 Temperature Range

Operating conditions	+15 to +45°C
Limit range of operation	+20 to + 55°C
Limit range for storage and transport	−25 to + 70°C

NOTES

1 For special application, other temperature values may be used according to purchase contract.

2 Storage and transport of the time switch should only be at the extremes of this temperature range for a maximum period of 6 hours.

3 The limit range for storage and transport may be unacceptable for batteries. In these cases, acceptable temperature should be clearly marked on the time switch.

4.3.2 *Relative Humidity*

The time switch shall be deemed to meet the relative humidity requirements of Table 3. For combined temperature and humidity test (*see* **5.3**).

Table 3 Relative Humidity

Annual mean	75 percent
For 30 days, these days being spread in a natural manner over the year	95 percent
Occasionally on other days	85 percent

The limits of relative humidity as a function at ambient temperature are shown in Annex B.

4.4 Electrical Requirement

4.4.1 *Power Consideration*

The active and apparent power absorbed by the time switch under the conditions of reference (*see* Annex C) shall be less than or equal to the following value:

3W, 5VA inductive of 25 VA capacitive.

These values may be exceeded briefly during the change of state of a switch.

4.4.2 *Supply Voltage Range*

Table 4 Supply Voltage Range

Operating conditicns	0.8 to 1.1 U_n
Limit range of operation	0.8 to 1.15 U_n

4.4.3 *Effect of Supply Voltage Long Interruption*

During an interruption of the supply voltage not exceeding the operation reserve, the time switch shall keep the time within the prescribed accuracy (*see* **4.5**). Upon restoring supply, the switch(es), shall be positioned according to their setting(s).

4.4.3.1 *Operation reserve*

The minimum operation reserve shall be 36 hours.

The maximum reserve restoration time shall be three times the value of the operation reserve.

4.4.3.2 *Battery life*

If operation reserve is provided by a rechargeable battery, its life shall be at least 5 years under normal operating conditions.

If operation reserve is provided by a primary cell battery, it shall be able to ensure operation reserve for at least 10 000 hours after it has been connected to the reserve, over a five-year period.

4.4.4 *Rated Breaking Voltage* (U_c)

The switch or switches shall be designed for standard rated voltages as indicated in Table 5 and operate correctly over a voltage range of 0.8. to 1.15 times these rated voltages.

Table 5 Rated Breaking Voltages (U_c)

Rated Breaking Voltages	
110 to 240 V	415 V

4.4.5 *Rated Breaking Current* I_c

The switch or switches of which the rated current are chosen from the table below shall be able to make, carry continuously and break under a voltage 1.15 U_c the currents shown in the following Table 6. This table concerns the breaking switches of the principal circuits.

For maximum demand indicator switches, the breaking capacity is limited to a maximum value of 1A with a power factor cos $\theta = 0.5$ lagging.

Table 6 Rated Breaking Current (I_c)

Rated Breaking Current I_c (A)	2	10	16	25	31.5	40	80
Linear ohmic Load cos $\theta = 1$: Current (A)	2	10	16	25	31.5	40	80
Inductive Load cos $\theta = 0.4$: Current (A)	1	5	8	10	10	10	10

4.4.6 *Number of Operations of the Output Element*

Each output element shall be capable of carrying out correctly 30 000 operations either under ohmic load conditions or under the inductive load conditions given in **4.4.5**. Maximum demand indicator switch contacts (or their static equivalent) shall withstand 400 000 switching operations at 20 VA and power factor of 0.5 lagging, when the shortest programmable integration period is 15 minutes. The number of operations has to be increased proportionally when the period is shorter (that is, 600 000 operations for an integrations period of 10 minutes or 1 200 000 for 5 minutes).

4.4.7 *Short-Circuit Performance of the Output Element*

The short-circuit performance shall be determined by the characteristics of the supply fuse so that:

a) With prospective short-circuit current of 7 kA rms and a power factor of 0.5, it ensure that the surroundings of the time switch are not endangered and that protection against indirect contact is assured in all cases; and

b) With a prospective short-circuit current of 3 kA rms and a power factor of 0.8 the output element still operates under specified performances.

The characteristics of the supply fuse are to be agreed upon case by case.

Protection against indirect contact shall also be assured after the application of a short-circuit from a source with a prospective current of 7 kA rms through a supply fuse with a rating corresponding to the rated breaking current.

a) either according to the (higher) rated, breaking current, in which case damage may occur to the contacts as a result of a short-circuit, although the probability of such damage is small in practice; and
b) or according to the short-circuit performance stated above.

4.4.8 *Heating*

Under normal conditions of use, electrical circuits and insulation shall not reach a temperature which might adversely affect the operation of the time switch. The temperature rise of the external surface of the time switch shall not exceed 25°K with the ambient temperature at 40°C.

4.4.9 *Insulation*

The time switch shall be such that it retains adequate dielectric qualities under normal operation of use, taking into account the atmospheric conditions and different voltages to which the circuits are normally subjected.

The time switch shall withstand the impulse voltage test and the ac voltage test as specified in **5.4.6**.

4.5 Time-Keeping Accuracy

4.5.1 *Synchronous Time Switches*

Synchronous time switches shall have a time-keeping accuracy under normal operating conditions of better than 1 minute/year assuming that the supply frequency keeps its nominal value on the supply frequency keeps its nominal value on the average. After running on operation reserve for 36 hours, at reference temperature, the time-keeping accuracy shall be better than 180 seconds/day where operation reserve is provided by a spring and better than 1.5 seconds where operation reserve is provided by a battery.

4.5.2 *Crystal-Controlled Time Switches*

At reference temperature, crystal-controlled time switches shall have a time-keeping accuracy better than 0.5 seconds/day. After running on operation reserve for 36 seconds/day. After running on operation reserve for 36 hours, the time keeping accuracy shall be better than 1.5 seconds.

The variation of the time-keeping accuracy with the temperature shall be less than 0.1s/°C/24 h.

4.5.3 *Maximum Demand Indicator Switch*

The actual integration time of a maximum demand indicator switch shall not differ by more than 1 percent from the set value. The MD 1 switch shall be active for the reset of the MD1 during a time greater than 0.8 percent and smaller than 1.2 percent of the integration time.

4.6 Electromagnetic Compatibility (EMC)

4.6.1 *Immunity to Electromagnetic Disturbance*

The time switch shall be designed in such a way that conducted or radiated electromagnetic disturbances as well as electrostatic discharges do not damage nor substantially influence the time switch.

NOTE — The disturbance to be considered are:

a) Harmonics;
b) Voltage dips and short interruptions;
c) Electrostatic discharges;
d) Electromagnetic fields;
e) Conducted transients; and
f) dc and ac magnetic fields.

4.6.1.1 *Immunity to harmonics*

The time keeping accuracy of the time switches shall not be affected by the presence of harmonics on the supply network, the harmonic level considered is 10 percent of harmonic 3.

4.6.1.2 *Immunity to short interruption and voltage dips*

4.6.1.2.1 *Synchronous time switch short voltage interruptions*

Each time a voltage interruption occurs, the time-keeping accuracy of the time switch shall not be affected by more than the value of the voltage interruption itself if this interruption is less than 500 ms and more than 500 ms if the interruption is longer than 500 ms.

4.6.1.2.2 *Synchronous time switch voltage dips (brown effect)*

If the mains drops to 50 percent of its value, the time switch either continues to operate normally on time mains or operates on its operating reserve. The time-keeping accuracy shall in no way be affected by more than 500 ms in addition to the inaccuracy due to working on operation reserve.

4.6.1.2.3 *Crystal-controlled time switch short voltage interruption*

Each time a voltage interruption occurs, the time-keeping accuracy shall not be affected by more than 20 rms whatever the length of the short voltage interruption.

4.6.1.2.4 *Crystal-controlled time switch voltage dips (brown effect)*

If the mains drops to 50 percent of its value, the time switch either continues to operate normally on the mains or operates on its operations reserve. The time-keeping accuracy shall in no way be affected by more than 500 ms in addition to the inaccuracy due to working on operation reserve.

4.6.1.3 *Immunity to electrostatic discharges*

15 kV electrostatic discharges applied shall not affect the correct operation of the time switch which should in particular maintain the time and the position of the output contacts.

4.6.1.4 *Immunity to radiated electromagnetic fields*

The time switch shall not be affected by radiated electromagnetic fields with a intensity of V/m in 27 WHz band. The time switch should in particular maintain the time and the position of is output contacts.

4.6.1.5 *Immunity to fast transient bursts*

The time switch shall not be affected by fast transient bursts of 2 kV applied. The time switch should in particular maintain the time and the position of its output contacts.

4.6.1.6 *Immunity to continuous magnetic fields*

The time switch should be insensitive to the application of continuous magnetic fields whose value shall be agreed upon between the user and the supplier. In particular, the output contacts should maintain their position and switch-over in accordance with their programming.

4.6.1.7 *Immunity to magnetic fields of mains frequency*

The time switch should be insensitive to the application of a magnetic field of mains frequency of 0.5 mT and in particular, the time switch should maintain its time-keeping accuracy and the position of its output contacts.

4.7 Radio Interference Suppression

The time switch shall not generate conducted or radiated noise which would interfere with other equipment.

5 TEST AND TEST CONDITIONS

5.1 Test Conditions

All tests are carried out under reference condition as stated in Annex C unless otherwise stated in the relevant clause.

5.1.1 *Type Test*

See Note under **5.1.3**.

5.1.1.1 *Criteria for conformity*

See Note under **5.1.3**.

5.1.2 *Routine Tests*

See Note under **5.1.3**.

5.1.3 *Acceptance Tests*

See Note under **5.1.3**.

NOTE — Suggestions are invited on these clauses.

5.1.3.1 *Recommended sampling plan and criteria for acceptance*

See Annex D.

5.2 Test of Mechanical Requirements

5.2.1 *Spring Hammer Test*

The mechanical strength of the switch case shall be tested with a spring hammer.

The time switch shall be mounted in its normal working position and the spring hammer shall act once on each of the outer surfaces of the cover with a kinetic energy of 0.22 ±0.05 J.

The result of the test is satisfactory, if the time switch case and the terminal cover do not sustain damage which would affect the function of the time switch and it shall not be possible to touch live parts. Slight damage which does not impair the protection against indirect contact or the penetration of solid objects, dust and water, is acceptable.

5.2.2 *Shock Test*

This test shall be carried out according to IS 9000 (Part 7/Sec 1) under the following conditions:

a) Time switch in non-operating condition, without packing;
b) Half sine shock;
c) Peak acceleration: 294 m/s^2 930 g; and
d) Duration of the pulse: 18 ms.

After the test, the time switch shall show no damage and shall operate correctly.

5.2.3 *Vibration Test*

The test shall be carried out according to IS 9000 (Part 8) under the following conditions:

a) Switch in non-operating condition, without packing;
b) Test procedure A;
c) Frequency range: 10 Hz to 150 Hz;
d) Transition frequency: 60Hz;
e) $f < 60$ Hz constant amplitude of movement: 0.075 mm;
f) $f > 60$ Hz constant acceleration : 9.8 m/s^2 (1 g);
g) Single point control; and
h) Number of sweep cycles per axis: 10.

NOTE — 10 sweep cycles = 75 minutes.

After the test, the time switch shall show no damage and shall operate correctly.

5.3 Test of Climatic Influence

After the test, the time switch shall show no damage and shall operate correctly.

5.3.1 *Dry Heat Test*

The test shall be carried out according to IS 9000 (Part 3/Sec 1 to 5) under the following conditions:

a) Time switch in non-operating condition without battery;
b) Temperature: 70 ± 2°C ; and
c) Duration of the test: 72 hours.

5.3.2 *Cold Test*

The test shall be carried out according to IS 9000 (Part 2/Sec 1 to 4) : 1977 under the following conditions:

a) Time switch in non-operatating condition,
b) Temperature : 25 ± 3°C ; and
c) Duration of the test : 72 hours.

5.3.3 *Damp Heat Cyclic Test*

The test shall be carried out according to IS 9000 (Part 5/Sec 1 and 2) under the following conditions:

a) Time switch in operating condition;
b) Without any current in the output element(s);
c) Varient 1;
d) Upper temperature: 40 ± 2°C;
e) No special precautions shall be taken regarding the removal of surface moisture; and
f) Duration of the test: 6 cycles.

24 hours after the end of this test, the time switch shall be submitted to the following tests:

a) An insulation test according to **5.4.5**, except that the surge voltage shall be multiplied by a factor of 0.8; and
b) A functional test. The time switch shall show no damage and shall operate correctly.

The damp heat test also serves as a corrosion test. The result is judged visually. No trace of corrosion likely to affect the functional properties of the time switch shall be apparent.

5.4 Test of Electrical Requirements

(For requirements, *see* **4.4.1**).

5.4.1 The power consumption shall be determined for the reference values of the influence quantities given in Annex B by any suitable method. The overall precision shall be better than 5 percent.

5.4.2 *Test of Effect of Supply Voltage Long Interruption*

(For requirements, *see* **4.4.3**).

The time switch to be tested is powered together with a reference clock. If the operation reserve consists in a rechargeable battery or in a spring the time switch has to be powered for at least 108 h before the test is performed.

If the operation reserve consists in a primary cell battery, the time switch has to be powered for at least one hour before the test.

The power supply of the time switch under test is switched off for 36 hours. When the power supply is restored, the difference in time between the reference clock and the time switch under test shall not exceed:

a) 180 s for spring reserve operated time switch; and
b) 1.5 s for battery reserve operated and crystal controlled time switch.

It is also to be verified that, when the supply is restored to the time switch, the output switches return to the position they should have, according to the true time. This test shall be carried out for all possible positions of the output switches. The restoration of voltage shall be made with device free from bounce.

5.4.3 *Test on Number of Operations of the Output Element*

(For requirements, *see* **4.4.5** and **4.4.6**).

The switch contact(s) of the time switch shall be tested with the fully assembled time switch under reference condition and shall be connected in a test circuit which comprises essentially a supply source, a protective device and a loading impedance.

The supply voltage to the test circuit shall be set to 1.15 times the rated breaking voltage and the loading impedance shall be adjusted to give the current indicated in **4.4.5**. For the test with ohmic load, the loading impedance consists of a pure resistance and for the test with inductive load (cos θ= 0.4), it consists of a resistance and inductive in series (if an air-core industry is used a resistor passing at least 0.6 percent of the coil current shall be connected in parallel with it).

The test shall be carried out with different sets of switch contacts for ohmic and inductive load. In case of load switch contacts and tariff register switch contacts (or their static equivalent) 30 000 operations shall be carried out.

For the test of the maximum demand indicator switch contacts (or their static equivalent), the leading impedance consists of a resistance and inductance in series in order to get a power factor of 0.5. The current in the test circuit has to be adjusted to such a value that, under rated breaking voltage, the apparent power obtained is 20 VA. The number of operations to be carried out is related to the shortest programmable integration period but has to be at least of 400 000.

The time between the changes of state shall be set:

a) For load switches and tariff switches with a frequency not exceeding 8 switching operations per minute; and

b) For maximum demand indicator switches with a frequency not exceeding 1 switching operation per second.

The test is passed if, after those tests the power loss of the output elements under rated breaking current shall not exceed 3 W or the voltage drop across the output elements shall not exceed 1 V and the open contacts may withstand an ac test voltage of 1 000 V rms for 1 min.

5.4.4 *Test of Short-Circuit Performance of the Out-put Element*

(For requirements, *see* **4.4.7**).

The short-circuit requirements shall be tested in a test circuit comprising the series connection of the following elements:

a) A current source with a prospective short-circuit of:
   7 kA rms with cos θ = 0.5
   or
   3 kA rms with cos θ = 0.8;

b) Fuse;

c) A switch closing at zero voltage cross over; and

d) The closed contact of the output switch.

The climatic conditions during the test shall have the reference values given in Annex C.

Stage 1: Test with a fuse corresponding to the rated breaking current (With a rated current equal to or immediately above the rated breaking current of the switch).

The short-circuit tests shall be carried out with a prospective short-circuit current of 7 kA rms. The test is passed if the protection against indirect contact remains assured. The contacts may weld.

State 2: Test with fuse corresponding to the ability to withstand short-circuits.

(Fuse characteristics to be agreed on)

The short-circuit tests shall be carried out with a prospective short-circuit current of 3 kA rms. The test is passed if the output switch may still be operated. This functional check shall be made with one of the programmable sequences with the reference values of Annex C.

5.4.5 *Test of Influence of Heating*

(For requirements, *see* **4.4.8**).

The temperature rise of the external surface of the case and terminal cover shall not exceed 25°K with an ambient temperature of 40°C after the output elements of the time switch have been carrying the maximum total capacity of the rated breaking current for two hours.

During the test, the time switch shall not be exposed to draught or direct solar radiation.

The other influence quantities shall have their reference values as given in Annex C, except for the supply voltage which shall be 1.15 U_n.

After the test, the time switch shall show no damage and shall comply with the dielectric tests of **5.4.6**.

5.4.6 *Test of Insulation Properties*

(For requirements, *see* **4.4.9**).

5.4.6.1 *General test conditions*

The tests shall be carried out only on a complete time switch, with its cover (except when inducted thereafter) and terminal cover, the terminal screws being screwed down to the maximum applicable conductor fitted in the terminals.

The impulse voltage tests shall be carried out first and the ac voltage tests afterward.

During type tests, the dielectric property tests are considered to be valid only for the terminal arrangement of the time switch which has undergone the tests. When the terminal arrangements differ, all the dielectric property tests shall be carried out for each arrangement.

For the purpose of these tests, the term 'earth' has the following meaning:

a) When the time switch case is made of metal, the earth is the case itself placed on a flat conducting surface; and

b) When the time switch case or only a part of it is made of insulating material, the earth is a conductive foil wrapped around the time switch and connected to the flat conducting surface on which the time switch base is placed, where the terminal cover makes it possible, the conductive foil shall approach the terminals and the holes for the conductors within a distance of not more than 2 cm.

During the impulse and ac voltage tests, the circuits which are not under test are connected to the earth as indicated hereafter.

A flashover (capacitances discharge) is no necessary criterion of failure as this may occur in a position that does no damage and the manufacturer shall decide whether or not to eliminate the cause provided other criteria of acceptance are met.

These tests shall be made in normal conditions of use. During the test, the quality of the insulation shall not be impaired by dustor abnormal humidity. Unless otherwise specified, the normal conditions for insulation tests are:

a) Ambient temperature: 15°C;

b) Relative humidity: 45 percent to 75 percent; and

c) Atmospheric pressure: 86 kPa to 106 kPa (860 mbar to 1 060 mbar).

5.4.6.2 *Impulse voltage test*

The waveform and the generator characteristics whose peak value shall be of 6 kV. For each test, the impulse voltage is applied ten times with one polarity and then repeated with one other polarity, the minimum time between the impulses shall 3 seconds.

a) *Test for insulation of the time switch circuits from the 'Earth'*
All terminals of the time switch shall be connected together, the impulse voltage shall be applied between these connected terminals and 'Earth'; and

b) *Surge voltage test for the input elements*
The impulse voltage shall be applied between the imput terminals of the time switch.

5.4.6.3 *ac voltage test*

The test voltage shall be practically sinusoidal, of rated frequency and be applied for one minute.

A test of voltage of 4 kV rms for protective class II times switches, and 2 kV rms for protective class I time switches shall be applied between all the terminals connected together and any exposed metal or earth and 1 kV (rms) between the open contacts. Furthermore, when the output circuits are galvanically insulated from the input element a test voltage of 2 kV shall be applied between each electrically independent circuit and all other circuits, which shall be connected to 'Earth'.

5.5 General Test Conditions

5.5.1 Place the time switch to be tested in its normal operating position and if necessary in a climatic chamber allowing it to be submitted to the conditions of temperature and humidity indicated in the table in Annex B and supplied by an apparatus exempt from short interruptions or voltage dip, allowing the conditions given in this table to be maintained.

Before performing tests, the time switch with rechargeable battery shall have been powered up for 108 h to ensure the reserve has been restored.

5.5.2 *Test for Synchronous Time Switches*

5.5.2.1 *Test of time switch supply by mains*

The time switch to be tested is supplied together with a reference mains controlled clock. After a testing period of 30 days, the time difference between the reference clock and the time switch to be tested shall be lower than 5 s.

5.5.2.2 *Test of time switch on operation reserve*

See **5.4.2**.

5.5.3 *Test of Crystal-Controlled Time Switches*

5.5.3.1 *Test of time switch supplied by mains*

The time switch is supplied together with a reference crystal controlled clock. After a testing period of 30 days, the difference between the reference clock and the time switch to be tested shall be lower than 15 s.

5.5.3.2 *Test of time switches on operating reserve*

See **5.4.2**.

5.5.3.3 *Test of time-keeping accuracy with temperature*

The time switch is placed in a climate chamber and its time base is measured at 23°C.

The temperature is set at 45°C. After thermal equilibrium is obtained, the time measured and shall not differ from the 23°C. Measurement by more than ±25 ppm.

The temperature is than set at –10°C. After thermal equilibrium is obtained the time base is measured and shall not differ from the 23°C measurement by more than ± 38 ppm.

5.5.4 *Test of Maximum Demand Indicator Switch*

The maximum demand switch of the time switch is connected to a standard counter/chronometer. The test is performed on 100 cycles. The maximum error shall be, under these conditions, and after the 100 cycles lower than one integration period (1 percent).

5.6 Test for Electromagnetic Compatibility

5.6.1 *General Test Conditions*

For all these tests, the time switch shall be in its normal working position with the cover in position. All parts intended to be earthed, shall be earthed. After these tests, the time switch shall show no damage and operate correctly.

5.6.2 *Test of Influence of Harmonics*

The time switch is supplied together with a reference clock. 10 percent of harmonic 3 are added to the time switch supply. The test is carried out over 30 days. At the end of the test, the timekeeping accuracy shall not vary by more than ±2 s from the result found in **5.5.2.1** and **5.5.3.1**.

5.6.3 *Test of the Effects of Short Supply Interruptions and Voltage Dips*

For these tests, the time switch is supplied together with a reference clock. A special equipment is inserted in the mains line of the time switch which shall be able to submit the equipment under test to programmable short supply interruptions and voltage dips without may bounce.

5.6.3.1 *Effects of short supply interruptions on synchronous time switches*

The time switch under test is submitted to sequence of 20 successive supply interruptions with at least 5 seconds interval between these interruptions. The value of interruptions to be applied shall be:

20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s 2 s.

After each test, the time-keeping accuracy of the time switch under test shall be better than the value of the Table given below.

Maximum Inaccuracies

Supply interruption length	20 ms	50 ms	100 ms	200 ms	500 ms	1 s	2 s
Maximum inaccuracy	400 ms	1 s	2 s	4 s	10 s	10 s	10 s

5.6.3.2 *Effect of voltage dips (brown effect) on synchronous time switches*

The time switch under test is powered by a mains with 50 percent of its rated value for 1 min.

After the test, the time-keeping accuracy of the time switch under test shall not vary by more than 500 ms plus the inaccuracy due to working on operation reserve (1 ms for electronic time switches and 125 ms for time switches with operation reserve provided by a spring).

5.6.3.3 *Effect of short supply interruptions on crystal controlled time switches*

The time switch under test is submitted to the same sequences of supply interruptions as described in **5.6.3.1**.

After each test, the time-keeping accuracy of the time switch under test shall not vary by more than 400 ms.

5.6.3.4 *Effect of voltage dips (brown effect) on crystal controlled time switches*

The time switch under test is powered as in **5.6.3.2**. After the test, the time-keeping accuracy of the time switch under test shall not vary by more than 20 ms plus the inaccuracy due to working on operation reserve (1 ms).

5.6.4 *Test of Immunity to Electrostatic Discharge*

The test shall be carried out under the following conditions:
Time switch in operating condition:

a) Circuits is energized with reference voltage,
b) Test voltage 15 kV, and
c) Number of discharges: 10.

The application of the electrostatic discharge shall not produce any change in the time displayed or in the position of the switch contact(s). The time switch shall show no damage and shall stay within the accuracy of this standard.

5.6.5 *Test of Immunity to HF Electromagnetic Fields*

The test shall be carried out under the following conditions:

a) Time switch in operating condition;
b) Circuits energized with reference voltage;
c) Frequency band: 27 MHz to 500 MHz; and
d) Test field strength: 10 V/m.

The application of the HF field shall not produce any change in the time displayed or in the position of the switch contact(s).

5.6.6 *Fast Transient Burst Test*

The Test shall be carried out under the following conditions:

a) Time switch in operating condition,
b) Circuits energized with reference voltage,
c) Test voltage: 2kV, and
d) Duration of the test: 60s.

The bursts shall be applied only to the supply terminals of the time switch. The time switch shall be tested for one minute on both positive and negative polarity.

It shall be checked that bursts did not impede the normal operation of the time switch and that load, tariff and maximum demand indicator switches switch on and off correctly.

5.6.7 *Test of Immunity of Continuous Magnetic Fields*

The test for the effect of external magnetic fields shall be carried out with a coil carrying direct current described in Annex E, which is moved over all the faces of the case. The value of the magneto-motive force (in ampere-turns) to be applied shall be agreed upon between user and supplier.

During the test, the time switch must retain its operational capacities (the influence quantities having their values as given in Annex C).

5.6.8 *Test of Immunity to Magnetic Field of Mains Frequency*

The test shall be carried out by moving the time switch inside a coil of 1 m diameter and 400 Ampere-turns (0.5 mT).

During the test, the time switch shall retain its operational capacities (the influence quantities having their values as given in Annex C).

5.7 Switching Device (or Contacts)

The final switching device (or contacts) should be separate units which may be replaced easily when contacts are burnt or after expiry of their life.

ANNEX A

(*Clause* 2)

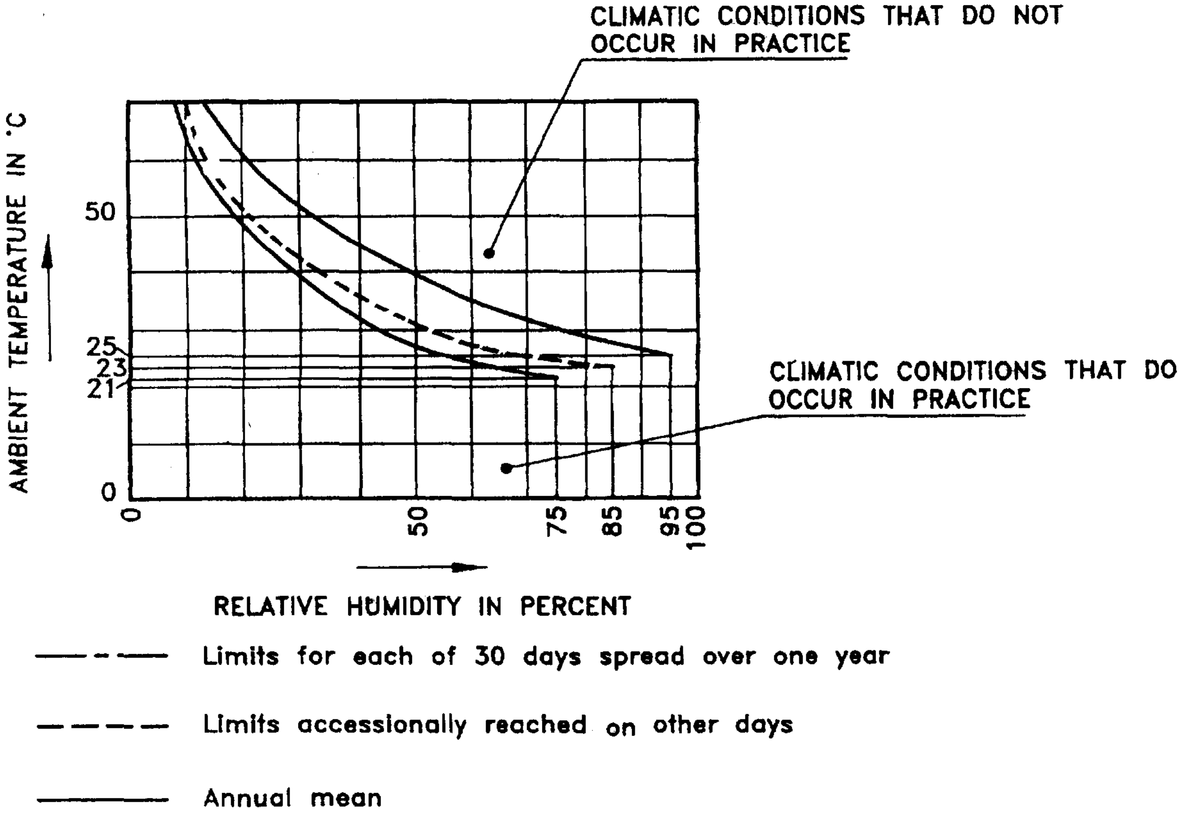
LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
9000	Basic environmental testing procedures for electronic and electrical items
(Part 1) : 1988	General *(first revision)*
(Part 2/Sec 1 to 4) : 1977	Cold test (Sections 1 to 4 in one volume)
(Part 3/Sec 1 to 5) : 1977	Dry heat test (Sections 1 to 5 in one volume)
(Part 5/Sec 1 and 2) : 1981	Dampheat (cyclic) test, Section 1 16+8h cycle, Section 2 12+12h cycle
(Part 7/Sec 1 : 1979)	Impact test, Section 1 Shock
(Part 8) : 1981	Vibration (sinusoidal) test

ANNEX B

(*Clauses* 4.3.2 *and* 5.4.1)

RELATIONSHIP BETWEEN AMBIENT AIR TEMPERATURE AND RELATIVE HUMIDITY



ANNEX C

(*Clauses* 4.4.1, 5.1 *and* 5.4.4)

REFERENCE AND LIMITING VALUES OF THE INFLUENCING QUANTITIES

Influencing Quantity	**Reference Value**			**Limiting Value**	
	Value	Tolerance	Maximum	Minimum	Tolerance
Supply voltage (V)	U_n	±1%	1.5 U_n	0.80 U_n	±1 %
Supply frequency (Hz)	f_n (see Note 2)	±0.1	1.01 f_n	0.98 f_n	±0.1%
Temperature (K)	+23	±3	+55	− 25	±2
Relative humidity (%)	65	±10	95		+0 −0.5

NOTES

1 U_n : the possible values of U_n are those stated in **4.1.1**; and

2 f_n : the possible value of f_n are those stated in **4.1.2**.

ANNEX D

(*Clause* 5.1.3.1)

SAMPLING PLAN FOR ACCEPTANCE TESTS

D-1 SCALE OF SAMPLING

D-1.1 Lot

In any consignment, all the time switches of the same rated voltage, current frequency and manufactured by the same factory, during the same period shall be grouped together to constitute a lot.

D-1.2 From each lot a certain number of time switches shall be selected at random and subjected to acceptance tests. Any time switch failing to satisfy the appropriate requirements specified the appropriate requirements specified in the specification shall be considered as defective.

D-1.3 The number of time switches to be selected shall depend on col 1 and 2 of Table 7. These time switches shall be taken at random.

D-1.3.1 In order to ensure the randomness for selection, random number tables shall be used (*see* IS 4905)

Table 7 Scale of Sampling

(*Clause* D-1.3)

Lot Size	First Stage	Second Stage	Acceptance Criteria			
N	n	n	$2n$	C_1	C_2	C_3
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Up to 150	8	8	16	0	2	2
151 to 500	13	13	26	0	3	4
501 to 1 000	20	20	40	1	4	5
1 001 and above	32	32	64	2	5	7

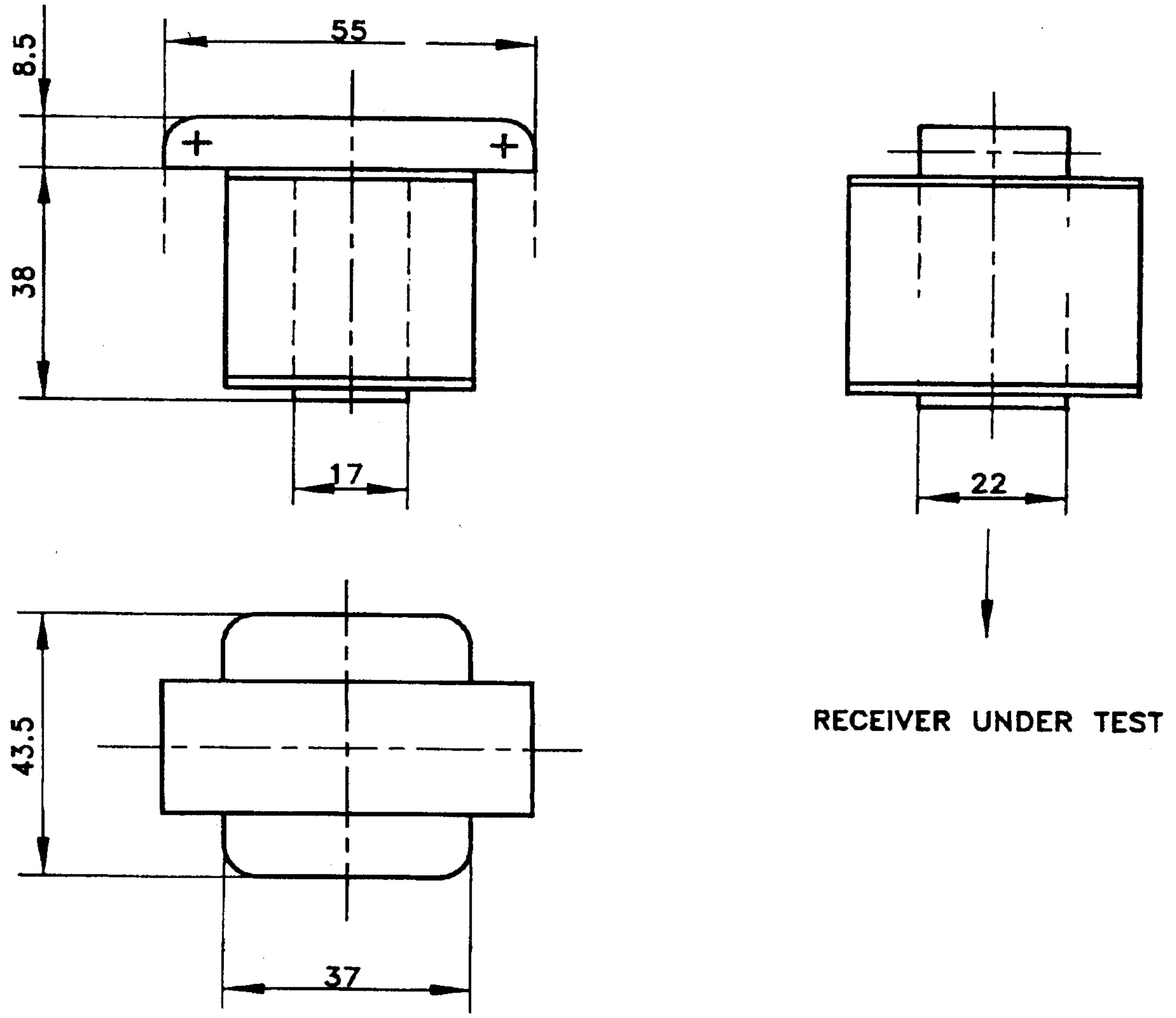
D-2 NUMBER OF TESTS AND CRITERIA FOR ACCEPTANCE

D-2.1 Each of the time switches selected in the first stage in accordance with col 2 of Table 7 shall be tested for acceptance (*see* **1**). If the number of defectives is less than or equal to C_1, the lot shall be considered as conforming to the requirements of the standard. If the number of defectives is equal to or greater than C_2, the lot shall be considered as not conforming to the requirements of the standard. If the number of defectives in the first stage sample is between C_1 and C_2, a further sample of same size as taken at the first stage shall be taken and tested. If the number of defectives in the two samples combined is less than C_3, the lot shall be considered as conforming to the requirements of the standard, otherwise not.

ANNEX E

(*Clause* 5.6.7)

ELECTROMAGNET FOR TESTING THE INFLUENCE EXTERNALLY PRODUCED MAGNETIC FIELDS



All dimensions in millimetres.

Examples of winding : 500 turns 0.6θ/0.28 mm^2
or : 1 000 turns 0.4θ/0.126 mm^2
Core Laminations : 1.0 W/kg

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 323 01 31, 323 33 75, 323 94 02

Telegrams: Manaksanstha
(Common to all offices)

Regional Offices: Telephone

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
NEW DELHI 110002 — 323 76 17, 323 38 41

Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola
CALCUTTA 700054 — 337 84 99, 337 85 61, 337 86 26, 337 91 20

Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022 — 60 38 43, 60 20 25

Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600113 — 235 02 16, 235 04 42, 235 15 19, 235 23 15

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